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ON EPIDEMICS AMONGST MICE KEPT AT THE HYGIENIC INSTITUTE AT GREIFSWALD AND ON THE BEST MEANS OF COMBATING A PLAGUE OF FIELD MICE.*

By Professor F. Loeffler.

Diseases amongst mice kept for experimental purposes in scientific institutions are of somewhat rare occurrence, and I do not know that the appearance of an epidemic amongst them has ever previously been observed. I am, however, in a position to give an account of what has occurred amongst the white mice kept at this Hygienic Institute within the last few years. These are not merely of bacteriological interest, but, as I shall show, they are of no little practical interest also.

The stock of white mice at the Institute is kept in two quadrangular glass cases, each about 40 cm. square, which are covered with wide-meshed wire gauze. The mice are fed on oats and pieces of bread softened by being dipped in water. The bottom of the cages is covered with sawdust, over which a little straw is scattered, so that the mice may hide in it.

In July, 1889, the attendant informed me that while cleaning a cage which contained about forty mice, he had found dead ones amongst them for some little time. I immediately made an inspection, and found three in a cage apparently diseased. They were at once isolated, and died in the course of the two following days. On dissecting the first I found the typical condition of Koch's "mouse-septicæmia" (*Mäuseseptikämie*). The culture from the organs affected confirmed the diagnosis. Dissection and culture showed that the other two mice had also died of this "mouse-septicæmia." During the next few days three more died in the same case, all from the same cause. According to the attendant's report, at least fifteen mice died, and all probably from the same disease. It is highly probable that the infection was conveyed through the digestive system, as the first mice found dead had been partly devoured. We did not discover the cause of the appearance of the epidemic in the cage. Nothing had been done in observing the bacilli of "mouse-septicæmia." When the infected and diseased animals were removed, it ceased.

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* Translated from the German 'Centralblatt für Bakteriologie und Parasitenkunde,' Band xi. pp. 129—141 (10 Feb. 1892).

It is of special interest to find the bacillus which Koch employed to produce disease among mice by inoculation, spontaneously producing an epidemic disease among mice in captivity.

The second much more important and extensive epidemic broke out in October, 1890. There were ten mice in the first cage, and forty-five in the second. All the deaths occurred in the second cage. The ten mice in the first cage were fed and treated in exactly the same way as those in the adjoining cage, but remained quite healthy.

The attendant noticed that several mice died about the 7th to the 10th of October; and by the 19th eight of the forty-five mice were found dead in the cage. I was not told that the mice were dying till the 19th October, when another large mouse was found dead. I immediately gave orders that all dead mice should be given to me for examination. On Oct. 20th two mice (1 and 2) were found dead, and a mouse which appeared diseased was isolated in the morning, and died in the afternoon (3).

On the morning of Oct. 21st three more mice were found dead (4, 5, 6), and five apparently diseased ones were isolated. In the afternoon an old one (7) and a young one (8) lay dead in the cage.

On the 23rd a young diseased mouse was isolated. It died in the afternoon (9).

On the morning of the 25th one of the isolated mice died (10). In the afternoon two more died (11 and 12).

After this all the large mice were taken out of the cage, and each isolated in a glass. The large case was emptied, cleaned, and disinfected with a solution of corrosive sublimate of the strength of one per cent. The young mice were then replaced.

Oct. 27th. Four large isolated mice died (13—16). Three small ones died in the cage (17—19).

Oct. 31st. An isolated mouse died (20).

Nov. 1st. A small one died in the cage (21).

Nov. 2nd. A large isolated mouse died (22).

Nov. 7th. Another of the same died (23). With the death of this mouse the epidemic came to an end. In the course of four weeks thirty-one mice had died out of forty-five in the cage, the mortality thus amounting to 69 per cent. The first eight mice were not examined, but all the others were. All those examined had died of the same disease, and no doubt this was the case with the first eight. The epidemic must be regarded as uncommonly fatal. It is highly probable that all the mice would have died if the epidemic had not been arrested by strict isolation and disinfection.

Nearly all the mice found dead in the large cage had been more or less eaten. The brain was generally gnawed away, and in several cases the bodies were half-devoured. This fact, taken in connection with the observations on the first epidemic, which was caused by the bacilli of "mouse-septicæmia," leads to the suspicion that the infection is caused and multiplied by receiving the cause of the disease *per os*. Further investigations confirmed this suspicion.

The appearances, on dissection, were on the whole very similar, but varied considerably in individual cases. On opening the abdominal cavity, a splenetic tumour was almost always observed. The spleen was large, brownish red, and generally solid. The liver was usually parenchymatously turbid. It generally displayed a very large amount of fatty matter, and sometimes also showed small yellow specks. Sometimes the liver was very full of blood, and sometimes dry and shining; but it frequently exhibited an entirely normal appearance.

Now and then a mouse was found in which the abdominal cavity contained fresh blood, without my being able to discover the source of the hæmorrhage. The stomach and intestines showed numerous alterations. Very frequently slight hæmorrhage occurred in the mucous membrane of the pyloric region of the stomach, as well as at the anterior portion of the duodenum, and the "Peyer's bodies" were frequently congested, and also somewhat swollen. The lower part of the small intestine was generally filled with blackish contents. The mesenteric glands were distinctly, and sometimes considerably, swollen, dark reddish grey in colour, and permeated by hæmorrhage.

The kidneys were usually pale, sometimes parenchymatously coloured. The lungs were sometimes normal, and sometimes blotched with red. Here and there brownish red portions were visible. The brain exhibited nothing peculiar.

Bacteriological investigation gave precisely similar results in all the mice examined. On expressed preparations (*ausstrich-präparaten*) of the liver and the spleen, I found short bacilli, usually very numerous, but sometimes very sparingly, resembling the bacilli of pigeon-diphtheria (*Taubendiphtherie*). These varied in length and breadth, both in the same individual and in different cases. Many appeared truncated, especially when the bacilli were present in large masses, and many were strongly developed. In this respect the rods resembled those of the typhus-bacillus, which also varies in size within certain limits. When examined in hollow object-holders, they exhibited lively movements similar to those of the typhus-bacillus. This led to the suspicion that these, like the latter, might have multiple *flagella*. In fact, they behaved like the typhus-bacillus when macerated in a suitable infusion, but better still when macerated in rather strong alkali, which made the lateral *flagella* visible. In some mice bacilli could be detected in all the organs, while in others they were sought for (in blood from the cardiac region, for example) without success. But similar bacilli were obtained by culture from all the mice. Tubes of gelatine cultures were prepared from the liver, from the spleen, and from the cardiac region. The culture from the last named remained sterile in many cases, but colonies were invariably developed from the spleen, and especially from the liver. The number of these differed very considerably. Sometimes the whole surface of the gelatine was covered with an even coating of bacilli; sometimes the separate colonies were separated and developed at a considerable distance from each other, and sometimes only a few colonies appeared on the entire surface of the gelatine. On the whole, the number of colonies corresponded to the quantity of bacilli found in the expressed preparations. In those cases where no bacilli could be discovered with the microscope a few typical colonies were only developed exceptionally by cultivation.

The mode of increase of the bacilli was as follows:—On gelatine-tubes kept in the temperature of the room hardly anything was to be seen with the naked eye after twenty-four hours. But with the lens small colourless particles were already discernible. After forty-eight hours the colonies became visible as round, greyish white or bluish-hyaline bodies, about as large as a pin's head. During the next few days the colonies enlarged, if they were wide apart, till they formed patches from 3—4 mm. in breadth. They then generally lost their rounded shape, and formed zigzag protuberances with rough edges. Then the gelatine began to get somewhat turbid. Slight alterations in the composition of the gelatine (as happens with each new preparation) influenced the appearance of the colonies. In one preparation the colonies were always round and rather thick, and consequently but slightly transparent, and whiter. In another the condition already described appeared more like that of typhus-bacilli. The individual bacilli in this cultivation were of unequal length. Among the more numerous were short forms, with lively motions; others long and thread-like, sluggish, or even motionless. They were readily coloured by the aniline dyes employed, and best with the alkaline solution of methyline-blue, which I have elsewhere recommended.

In plate-cultivations (*plattenkulturen*), the deep-seated colonies appeared round, at first hyaline-grey and slightly granulated, afterwards yellowish brown, and strongly granulated. The colonies nearer the surface were strongly granulated, and delicately furrowed, like colonies of the typhus-bacillus, but not so prominent.

On "Agar-Agar," a greyish white and little-characteristic coating was formed. On blood-serum, and especially on sweetened peptonized bouillon, mixed with blood-serum, as I have elsewhere recommended, a transparent coating appeared. Distilled water soon became turbid. The formation of spores was not observed in any nutritive fluid, not even when heated.

They grew upon potatoes in a very characteristic manner. They formed a whitish and not very thick coating, and the adjacent substance of the potato showed a dirty greyish blue tint. In sweetened peptonized bouillon they grew very strongly. They rendered it turbid with the gas engendered, and then formed a thick cloudy layer on the surface. The previously neutral reaction of the bouillon now became rather strongly acid. The presence of alcohol in the distillation was proved by the iodine test.

The bacilli also developed well in milk. The appearance of the milk was not altered during their growth, but the reaction became rather strongly acid.

On examining sections of the organs, I found the bacilli generally arranged in masses within the capillaries. They formed masses, like those in human typhus. Now and then single specimens were seen in the capillaries; they often lay within them like large colourless cells. The yellowish spots in the liver, which were often perceptible to the naked eye, contained no more liver-tissue, and were generally surrounded by disintegrated matter. There was always a mass of bacilli in the centre of these portions. It appeared as if the bacilli had caused the disappearance of the liver-cells, and disintegration. In other places the masses lay in the normal tissue, without causing disintegration. The mesenteric glands were pervaded with enormous masses of bacilli. The appearances rather reminded me of those which I had obtained after inoculating mice with the bacilli of pigeon-diphtheria (*Taubendiphtheriebaccillen*).

The bacillus belongs indubitably to the group of typhus-like bacilli of which a considerable number are already known. As it has most resemblance to human typhus-bacillus, I propose to call it the bacillus of mouse-typhus (*Bacillus typhi murium*).

As regards the mode of infection, in this epidemic, it is undoubtedly caused by infection through the digestive organs. This is abundantly proved by the alterations in the small intestine, and in the mesenteric glands. I cannot positively affirm that the infection is caused entirely by nibbling a companion who has died of the disease. In a number of mice which I examined with all care I found bacilli in the contents of the intestine. I think it not improbable that living bacilli which have been evacuated with the fœces may get mixed with the food, and be thus swallowed by other mice. Young mice especially, which as a rule took no part in gnawing at the corpses, might have become infected by foul food. The possibility of infection by inhalation had also to be considered.

The opportunity for the pulverisation of bacilli in the straw is very favourable. The diffusion of germs through the air, if it happens at all (and I have not studied this mode of infection experimentally), is certainly of very subordinate importance. In the second mouse-cage, which stood close to that which contained the diseased mice, there was no infection.

The duration of the epidemic was somewhat lengthy. Eight mice were isolated on the 25th of October, and the last of these did not die until the 7th of November. If we assume that this mouse was only infected on the 25th of October, just before its isolation, thirteen days elapsed between the date of its infection and its death. The period between infection and death was experimentally established as from one to two weeks. I could not make these experiments on white mice until I was certain that the epidemic had really disappeared. I therefore waited for some weeks before I commenced with them.

In the meantime I resolved to make some experiments on other animals, to see whether they were susceptible to the bacillus. My chief interest centred in the Field Vole (*Arvicola arvalis*), which was obtainable in great abundance in the neighbourhood of Greifswald in November, 1890. Through the kindness of Dr. Ollmann and Dr. Hesse, I was easily enabled to procure plenty of these little animals for experiment. As is well known, Koch has proved that the Field Vole is proof against the minute bacillus of "mouse-septicæmia; but, on the other hand, I have established the fact that it is extremely susceptible to the bacillus of glanders; whereas the tame white mouse is proof against it. It therefore appeared doubtful to me whether the Field Vole would be susceptible to the bacillus causing the epidemic amongst white mice. On Nov. 10th I inoculated two Field Voles under the skin of the back with the gelatine culture obtained from the liver of the mouse which had died on Nov. 2nd. One Field Vole was found dead on Nov. 12th. The spleen was large, the liver moist and shining, and the lungs spotted. On making an expressed preparation of the liver, the typical bacilli were found in great abundance. In the gelatine-tubes a thick coating of bacilli was formed. On the same day, Nov. 12th, and immediately after the examination, this Field Vole was thrown into a cage amongst three healthy Field Voles, which at once began to gnaw the body.

On Nov. 14th, four days after the inoculation, the second Field Vole died. At the point of inoculation I found a yellowish fibrinous gathering containing enormous masses of bacilli, partly truncated, and partly enclosed by large colourless cells. Otherwise the result of the examination was as in Field Vole No. 1. A preparation of the liver exhibited very numerous bacilli, the presence of which was also proved by cultivation.

The three Field Voles which had fed on No. 1 died on the 17th, 18th, and 20th November respectively. They all exhibited the same conditions, and in particular the mesenteric glands were greatly enlarged, and of a brownish red colour.

The third Field Vole, which died on the 20th November, was again thrown into a cage with three others. These three all died on the 28th and 30th November, and on the 2nd December, after eight, ten and twelve days respectively. They appeared lively till about two days before their death. After this they appeared less lively, and at last sat huddled up, with erect hair. They were hardly dead when their comrades made them a source of death to themselves by devouring them. It is well known that Field Voles devour the dead or weak and sickly individuals of their own species. After this first experiment, I could no longer doubt that the *Arvicola* was at least as susceptible to the bacillus as the white *Mus*.

I made so many experiments in infecting Field Voles that I cannot repeat them all in detail. I will only say that the infection *per os* invariably succeeded, whether I threw them potato-cultivations, bread moistened with bouillon-culture, or only poured a few drops of the latter into the cage; the animals invariably died from eight to twelve days afterwards, and in every carcass the typical bacillus was present.

This proof of the great susceptibility of Field Voles to this bacillus, and their easy destruction by this means, seems to me to be of great practical importance to agriculture. In many districts these Field Voles are a veritable scourge. They cause enormous losses by their fecundity and voracity. Brehm gives an appalling picture of their habits and their importance to Agriculture in his *Thierleben* (vol. ii. p. 388). He says:—

> "Their food consists of every sort of vegetable substance. When they can obtain seeds they feed only on these, but at other times they content themselves with fresh grass and herbs, roots and leaves, clover, fruits and

berries. Beech-mast and nuts, corn, turnips and potatoes are badly attacked by them. When the corn begins to ripen they assemble in hordes in the fields, bite the stalks through at the base till they fall over, then gnaw them through above, and drag the ears into their burrows. During the harvest they follow the steps of the reapers from one crop to another, devour the corn that has dropped among the stubble, gather the ears up which have fallen in binding up the sheaves, and at last find their way to the stackyards, where they find provision for the winter. In the woods they collect the fallen haws, juniper-berries, beech-mast, acorns, and nuts in their burrows. During the hardest weather they fall into uninterrupted hibernation, but when milder weather returns they rouse up, and feed on their stores. They are incredibly voracious, and require much to satisfy them, but they cannot do without water.

"Field Voles are very gregarious, and live socially together, at least in pairs, but more commonly in great hordes, and therefore they link one burrow to another. They multiply with extreme rapidity. Even in April we find from four to eight young in their warm nests, which lie from 40 to 60 cm. below the surface of the ground, and are softly lined with fine fragments of hay or straw and moss; and in the course of the summer the female produces young from four to six times more. It is highly probable that the young of the first brood are themselves ready to breed in autumn, and the amazing increase in their numbers is thus easily explained.

"'Under favourable circumstances,' says Blasius, 'the Field Vole multiplies in an incredible manner. Many instances are known in which a large part of the harvest has been destroyed over large tracts of country by their inordinate increase, and more than a thousand acres of young beech trees have been destroyed by their gnawing the bark. Those who have never experienced such a vole-year can hardly form a conception of the almost incredible swarms of mice in the fields and plantations. They often appear in a particular neighbourhood without their gradual increase having been observed, as if they had suddenly come upon the earth by magic. It is possible that they sometimes migrate suddenly from place to place. But their rapid multiplication is generally foreshadowed for weeks beforehand by the increase of the Buzzards (*Mäusebussarde*). During the twenties, the Lower Rhine was repeatedly visited by such a plague. The fields were so undermined in places that you could scarcely set foot on the ground without touching a mouse-hole, and innumerable paths were deeply trodden between these openings. On fine days it swarmed with voles, which ran about openly and fearlessly. If they were approached, from six to ten rushed to the same hole to creep in, and unwillingly impeded each other's progress by crowding together. It was not difficult to kill half-a-dozen with one blow from a stick in the crush. All seemed to be strong and healthy, but mostly rather small, for the greater part were probably young ones. Three weeks after I revisited the place. The number of voles had actually increased, but the animals were apparently in a sickly state. Many had scurvy places or sores, often over the whole body, and even in those which appeared sound, the skin was so loose and delicate that it could not be roughly handled without destroying it. When I visited the place for the third time, four weeks later, every trace of them had disappeared. But the empty burrows and passages awakened a much more dismal feeling than when they swarmed with life. People said that the whole race had suddenly disappeared from the earth as if by magic. Many may have perished from a devastating pestilence, and many have been devoured by their fellows, as happens in captivity; but people also spoke of the innumerable hosts that had swum across the Rhine at several places in open day. No extraordinary increase was noticed anywhere over a wide area; but they seem to have disappeared everywhere at the same time, without reappearing elsewhere. Nature must have put a stop to their inordinate multiplication at the same period. It was fine warm autumn weather, apparently favourable to them to the last moment.' "

In order to give some idea of the vast hordes of Voles which sometimes appear in certain districts, I may state that in 1882, in the single district of Zabern, 1,570,000 field-mice were caught in fourteen days; in the district of Nidda, 590,427; and in that of Putzbach, 271, 941.

"In the autumn of 1856," says Lenz, "there were so many mice in one district of about four leagues in circumference between Erfurt and Gotha, about 12,000 acres of land had to be reploughed. The sowing of each acre at current wages cost 6s., and the ploughing up was estimated at 1s. 6d.; so that the loss amounted to from £2000 to £4500, and probably much more. On a single large estate near Breslau 200,000 were caught in seven weeks, and delivered to the Breslau manure-factory, which then paid a pfennig (half-a-farthing) per dozen for them. Some of the mouse-catchers were able to supply the factory with 1400 or 1500 per day. In the summer of 1891, 409,523 voles and 4707 hamsters were caught and counted in the district of Alsheim in Rhenish Hesse. The local authorities paid 2523 gulden (about £164) for them!

"In the years 1872 and 1873 it was just the same, and local complaints arose in all parts of the country about the vole-plague. It might be compared to one of the plagues of Egypt. Even in the day, on the sandy plains of the Mark of Brandenburg, thousands of voles were counted in particular fields, and in the rich corn-lands of Lower Saxony, Thuringia, and Hesse, they abounded to a fearful extent. Half the harvest was destroyed, hundreds of thousands of acres were left untilled, and thousands of pounds were spent on their destruction. Agricultural Societies and Governments were implored to seek ways and means of staying the plague.

"Sometimes these voles attack plantations. In 1813 and 1814 they caused so much destruction in England among freshly-planted trees of one or two years' growth as to cause serious alarm.* Throughout wide districts the little animals not only devoured the bark of all the saplings, but also peeled the roots of many oaks and chestnuts that were already fairly grown, and thus destroyed them. The Government was forced to take the most energetic measures to repair this enormous damage.

"Unfortunately, man is powerless against these voles. All the means of destruction which have yet been devised seem insufficient to check the inordinate multiplication of these greedy hosts; only Providence and the useful predaceous animals, to which man is so hostile, can help him. "Borers" have been used with good results, with which, where the soil permits it, holes are made in the ground, 12—18 cm. in circumference, and 60 cm. deep. When the voles fall in, instead of burrowing their way out, they devour each other. When the fields were being ploughed, children followed with sticks, and destroyed as many as possible. Smoke has been driven into the burrows, poisoned grain thrown in, whole fields saturated with a decoction of strychnine or spurge, *Euphorbia cyprissias* (*mit einem Absud von Brecknuss oder Wolfsmilch*). In short, every means has been adopted to get rid of this terrible pest; but in general all these methods have proved nearly useless, and some of them, especially poisoning, highly dangerous. The most efficacious poison not only destroys all the mice in a field, but likewise their worst enemies, and consequently our friends—foxes, martens, stoats, weasels, buzzards, owls, and rooks; besides partridges, hares, and domestic animals, from pigeons to horses and oxen,—a sufficient reason for abstaining altogether from the use of poison. It is painful to all naturalists and lovers of animals to see the enemies of the mice, as in 1872, poisoned and destroyed, instead of cared for and protected. Short-sighted people—farmers who cared more for hare-hunting than for making the best use of the land—were delighted when they found, besides dead mice, hundreds of poisoned rooks, buzzards, owls, foxes, weasels, and stoats; but they did not consider what mischief they had entailed upon themselves in their senseless efforts to destroy the voles. It was not the destruction of the useful but despised mouse-killers that concerned them, but when hares, partridges and domestic animals were also poisoned, they were at last induced to give up the use of poison. Till then, the warnings of far-seeing advisers were disregarded. The warnings which they had given, both verbally and in print, that laying poison in the fields might perhaps benefit the infected land, but not agriculturists, were not appreciated till too late. Besides poison, smoking out the voles was tried on suitable ground with satisfactory result. All the holes were stopped up, and poisonous coal and sulphur-smoke (bisulphide of carbon) was allowed to pour into the burrows which the voles reopened; but this efficacious mode of destroying them could not be employed everywhere, and was very expensive. People knew not what to do, because they had neglected to destroy the mice at the proper time."

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* This was in the Forest of Dean and in the New Forest.

Thus far Brehm. I believe it would be possible to destroy the Voles effectually by means of the bacillus which I have discovered, even if they did not devour their dead and dying comrades, as they do in captivity. It would be easy to produce any quantity of cultivated fluid, to drop it on bread or corn, and to scatter this infected food over the fields infested.

But, before attempting this experiment on a large scale, it would be necessary to make extensive trials to discover whether other animals besides Voles could be infected with the bacilli *per os*, or not. I have made a series of experiments in this direction, and have obtained the following results. The natural destroyers of the voles, namely, cats, are proof against the bacillus. I have fed five cats with many dead or dying house- and field-mice, and not one of them contracted the disease. I have also fed a large number of rats on the bacillus without their becoming affected.

Among the field-mice which were brought me I found several specimens of the "Brandmaus" (*Mus agrarius*), which is distinguished by a black stripe along the middle line of the back, over a reddish yellow fur; this species, too, did not become diseased. Nor did small singing birds of different kinds, whose food was damped with the solution, sicken. No result followed in the case of fowls, pigeons, guinea-pigs, and rabbits, though they were fed with infected food for a long time.

In the case of two four-weeks' old pigs, which were fed with large quantities of cultivated bacilli, one remained quite healthy after several months' observation, and the other died, eight days after the commencement of the experiment, of abdominal catarrh, which was probably not produced by the bacilli. No trace of the bacilli could be obtained from the organs of the animal by means of cultivation.

Amongst all the animals on which experiments were tried by infection through the digestive system, only the house-mouse and the field-vole have hitherto shown themselves susceptible. Consequently, the danger of other animals becoming affected by taking food infected by the bacillus is very slight. But in the meantime, before commencing an experiment upon a large scale, it would be necessary to make more extensive trial on animals of the most different kinds, especially on all the species which are of any importance to agriculture.

But I must premise that many of the animals which are not susceptible to the infection through their food, sicken and die when inoculated with the bacilli hypodermically. I succeeded with subcutaneous inoculation in the case of several rats, small birds, pigeons, and guinea-pigs. In the case of the birds, an extensive yellowish lardaceous infiltration was locally developed at the point of inoculation in the thoracic muscles, which led to necrotic separation of the diseased part. In this substance I found enormous masses of bacilli. But I could not obtain any from the liver of the dead animals by means of cultivation. They died in from three to eleven days after inoculation. Rabbits showed themselves to be only slightly susceptible. At the point of inoculation only slightly sympathetic inflammation appeared, or local discharges, which lasted for weeks, but finally healed up.

From the foregoing observations, I hope that the new *bacillus typhi murium* will give us a weapon which may be effectually used against the Field Voles which cause so much damage to agriculture. The best time for contending with them seems to me to be Spring, when the frosts are over, but before their food has become very abundant.

It is a very favourable circumstance that the bacillus retains its vitality for a long time both in the wet and in the dry state. Gelatine-cultures retain their vitality and infective properties after being kept for six months.

The question then arises, What is the origin of the epidemic? This question I cannot answer. The bacilli bear a certain resemblance to those which I have found in pigeon-diphtheria; also to those of the pseudo-tuberculosis of rabbits and guinea-pigs, which I discovered in 1883, when employed at the Hygienic Institute, and which I have carefully studied and experimented on; to the bacilli of the American and Danish swine-plague; to the bacillus of ferret-disease, the bacillus of the spontaneous rabbit-septicæmia of Eberth, the *bacterium coli commune*, and other forms belonging to the group of typhus-bacilli. It might perhaps be thought that the bacillus of mouse-typhus was related to one of the species of bacteria which I have mentioned, and might be a variety of one or other of them. But this cannot be the case. No work has been done in the Hygienic Institute for the last few years with any of those bacteria, except with the *bacterium coli commune*, and the bacilli of the spontaneous rabbit-septicæmia, which Prof. Eberth was kind enough to send me. But these are altogether different from the bacillus of mouse-typhus.

The next thing thought of was the possibility of infection through the food. But, though all the mice were fed on the same oats and bread, those in one cage were decimated by the epidemic, while not a single mouse sickened in the other. For the present, therefore, the origin of the bacillus remains in obscurity.

In the course of 1891 the same bacilli have twice caused a fatal epidemic among the mice in the Institute. In May it killed nine mice out of seventeen, and in September eighteen mice out of thirty-eight. On each occasion the epidemic could only be arrested by long-continued isolation of all the mice.

THE PLAGUE OF FIELD VOLES IN THESSALY, AND ITS SUCCESSFUL COUNTERACTION BY THE *BACILLUS TYPHI MURIUM*.*

By Professor F. Loeffler.

In the middle of March of the present year it was reported in all the papers that telegrams had been received from Larissa to the effect that the plains of Thessaly were infested with myriads of Field Voles, which threatened to destroy the whole harvest. This news was specially interesting to me, because I had published an article in the 'Centralblatt für Bakteriologie und Parasitenkunde' (Band xi. pp. 129-141, 10 Feb. 1892), in which I had announced a new bacteriological method of combating the plague of Field Voles. If the news in the papers was true, it offered me a rare and favourable opportunity to test the practical efficacy of the *bacillus typhi murium* which I had discovered. As I stated in my former paper, the bacillus, when absorbed through the digestive system, proved only fatal to house-mice and field-mice, but appeared to be perfectly innocuous to many other species of animals, such as cats, rabbits, guinea-pigs, pigs, small singing birds, pigeons, and fowls. I also stated that it was important for the practical utility of the bacillus to ascertain by numerous experiments that all farm-animals enjoyed similar immunity. I therefore made experiments in feeding sheep, which Councillor Becker, of Eldena, placed at my disposal in the most obliging manner. The results fully answered my expectations, for though the sheep is particularly susceptible to disease, those on which I experimented took enormous doses of the bacillus without showing the least symptom of illness, whilst all the voles which were treated with the same bacillus died, without exception, of "mouse-typhus" after the usual period of from eight to fourteen days. The results of the experiments rendered it in the highest degree probable that the larger farm-animals, such as horses and oxen, would likewise be proof against infection. In any case it seemed to me that the practical application of the bacillus might be tested without hesitation in the Thessalian fields which were threatened with such danger, where almost the only animal of importance in the neighbourhood, the sheep, had been proved to be unsusceptible to it.

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* Translated from the German 'Centralblatt für Bakteriologie und Parasitenkunde,' Band xii. pp. 1—17 (5th July, 1892).

On March 29th, the Greek Government, influenced by the report of his Excellency the Greek Ambassador at Berlin, M. Rangabé, who had studied the pamphlet I sent him, and perhaps partly also by telegraphic information, respecting the bacillus which I had discovered, from the eminent French bacteriologist, Prof. Pasteur, requested me to supply them with tubes of the virus for experiment in Thessaly. I felt no further hesitation about carrying out the experiments on a large scale.

It was first necessary for me to explain how the experiment was to be conducted, that there might be some certainty of attaining the desired result. I had learned from my experiments and observations that within the narrow limits of a cage the disease was communicated from one infected animal to another in the course of a few weeks, so that at length all were attacked. The infection was communicated by a healthy animal taking the bacillus in food fouled by the fœces of those already ailing which were charged with bacilli; and afterwards by their devouring the individuals which had died of the disease, and which swarmed with bacilli. The first mode of infection of course was possible in a state of freedom. But it was doubtful whether Field Voles in a state of nature would devour the bodies of their dead comrades, and feed on the brain and entrails, as they invariably do in captivity. Many experienced agriculturists, however, thought that they do feed on the dead corpses in the same way in a state of freedom, though others doubted whether this supposition was correct. Again, it seemed uncertain to me whether the voles would run from one burrow to another, and thus spread the disease. It was therefore not enough to infect a few mice, set them at liberty, and wait to see whether the disease would be propagated in the course of some weeks, as within the narrow limits of a cage; but it was needful also to devise some mode of infection in which the propagation of the disease by cannibalism should not be the main object. Doubtless the result would be obtained with much greater certainty if the bacillus were scattered with food in the most wholesale manner over all the lands infested by the voles in order to accomplish the destruction of the majority by primary infection. As I was doubtful (a doubt fully justified by subsequent experiments) whether the exhaustive undertaking which I contemplated in Thessaly could be carried out without my personal supervision, I promised his Excellency the Greek Ambassador, M. Rangabé, that I would consent to furnish the Greek Government with some preparations of the bacillus, though I was unwilling to do so because I was doubtful whether this means of destroying the voles could be carried out in the way which I intended, and because I was afraid that some mishap might occur which might have nothing to do with the method itself, but which might throw discredit on this entirely new bacteriological experiment. But I declared that I was quite ready to carry out my own experiments in Thessaly myself if the Greek Government would defray the travelling and hotel expenses for myself and an assistant. On April 1st I received a telegram informing me that the Greek Government invited me to come to Greece on the terms which I had offered. But, before definitely accepting the invitation, I wished first to ascertain a very important point, which was taken for granted, but which my experiments on other species of mice showed to be by no means necessarily the case, whether the Field Vole which had invaded Thessaly was really the same species, *Arvicola arvalis*, which occurs with us, and on which I had tested the action of the bacillus. The brown rat, which belongs to the genus *Mus* (*M. decumanus*), as well as a species distinguished by a black longitudinal streak along the back ("Brandmaus," *Mus agrarius*), had shown themselves proof against the action of the bacillus, when fed with it. I therefore telegraphed as follows to his Excellency, M. Rangabé:—

> "Before I start with my assistant, I should like to be certain that the Field Vole in question is *Arvicola arvalis*. The species is very important, as I have only established the action of the bacillus in *Arvicola arvalis*. Please enquire in Athens, and let me know.—Loeffler."

Next day I received the answer:—

> "It is *Arvicola arvalis*, called 'campagnol' in French.—Rangabé."

After this important preliminary was settled, I no longer hesitated to try the bacteriological conclusions with the Thessalian Field Vole. My preparations were quickly made. A large quantity of the bacillus on obliquely stiffened "Agar Agar" in glass tubes was prepared, and carefully packed in a case. Besides this, my assistant, Dr. Abel, and I both took two tubes with cultivations of the bacillus in our personal charge, so that, in case the large box should be lost, we should have some preparations as a foundation for other experiments. On Tuesday, April 5th, we started from Berlin, and after four days' constant travelling viâ the Brenner, Brindisi, Corfu and Patras, we arrived on April 9th in Athens. Next morning I announced our arrival to his Excellency, M. Konstantopulos, the Prime Minister. At ten o'clock arrived Dr. Pampoukis, the head of the bacteriological laboratory in Athens who was instructed by the Government to aid us in carrying out the experiments. The bacteriological laboratory in Athens, which was founded by the former Prime Minister, M. Trikoupis, at the instance of M. Chatzimichalis, the Professor of Pathology, forms a branch of the Pathological Institute conducted by Prof. Chassiotis. At the Institution were a dozen Thessalian Field Voles, which the Government had ordered to be sent to Athens at my request. We went thither with Dr. Pampoukis to see them, and to satisfy ourselves about the important question of the species.

I perceived at the first glance that the Thessalian Field Vole was undoubtedly different from our *Arvicola arvalis*. It was considerably larger, paler in colour, with large shining eyes, and a very short tail. It had a much more vigorous and rat-like appearance than our Field Vole.* It was enough to damp my expectations considerably to discover that I had to deal with an obviously different, though allied, species. Before we could think of undertaking any further measures and preparations for the practical application of my method in Thessaly, it was necessary to ascertain whether this species was susceptible to infection by the bacillus, especially *per os*. Three of these Field Voles were immediately subjected to subcutaneous inoculation with some of the cultivated bacillus which I had brought with me, and three others were fed with pieces of bread dipped into some virus diluted with water. When I afterwards visited his Excellency the Prime Minister, I informed him of my observations respecting the species, and declared that before anything further could be attempted, we must wait for the result of the experiments which had just been commenced.

The Director of the Agricultural Department of the Ministry, M. Gennadius, then added that the scientific determination of the species was rather difficult, and that the Thessalian Field Vole exhibited several of the characters of *Arvicola arvalis*, but that it might possibly be *Arvicola Savii*.

The question of the susceptibility of the Thessalian species asserted itself, to my great joy, much more rapidly and favourably than I had dared to hope. One of those inoculated died in two days, the second in three, and the third in three and a half days. All the bodies exhibited quantities of bacilli in the internal organs, which could also be obtained from them by the ordinary methods of cultivation. The first animal fed with infected matter died in five and a half days, and a second in seven days; both exhibited the characteristic pathological and anatomical changes of "mouse-typhus," *viz.*, enlarged spleen, parenchymatous liver and kidneys, and inflamed and swollen mesenteric glands.

From these results it appeared that the Thessalian vole was even still more susceptible to "mouse-typhus" than our *Arvicola*

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* Later on I propose to publish an exact description of the species, when I receive the specimens which I have had preserved in alcohol.

arvalis, which generally did not die until ten or twelve days after absorbing the bacillus with its food. The body of one of the inoculated voles which was left in the cage was found next morning half-devoured, the brain and liver being eaten away, although the three animals in the cage were plentifully supplied with food.

We at once commenced our preparations. In accordance with the experiments which I had carried out at Greifswald, the bacilli could be propagated in various inexpensive cultivating fluids. Infusions of oat- and barley-straw had proved very suitable for this cultivation. By adding one per cent. of peptone and one-half per cent. of glucose, or grape-sugar, to this infusion, cultivating fluids were obtained, in which milliards of bacilli could be developed at incubation-temperature in one night, after the addition of a few germs.

The next thing to be done was to sterilise these cultivating fluids in large quantities. The bacteriological laboratory was excellently fitted up, but did not of course possess apparatus for the preparation of hundreds of litres of cultivating-fluid. I had hoped to find a large steam disinfecting apparatus in Athens in which the sterilisation of large quantities of fluids might have been undertaken. But there was no large apparatus of the kind in the city. The only apparatus suitable for my purpose was in the University Hospital. It was a steam disinfecting apparatus of half a metre broad, and over one metre long, and was heated with coal. This apparatus was at once placed at my disposal in the most obliging manner by the authorities. The straw was boiled in large boilers in the kitchen of the Hospital. The decoction was poured through a sieve, and placed in glass flasks covered with wicker basketwork, to be sterilised in the flasks, the mouths of which were stopped with wadding. But although the flasks were put into a cold oven, and gradually heated, they could not sustain the sterilisation, owing to the very unequal strength of the glass. Two flasks out of three burst. Nor would large glass flasks containing six litres bear the sterilisation. We were consequently obliged to abandon the use of glass. The only material from which large vessels could be quickly and cheaply made, and which would bear the heating, was tin. But before having large vessels made of this material, it was requisite to ascertain whether the germs would multiply in tin. The bacilli yield an acid in the course of development, and perhaps their growth might be unfavourably affected by substances derived from the vessel which might be dissolved. A preliminary experiment, however, in a small tin vessel showed that the development of the bacillus proceeded without interruption. After this, four large milk-can-like vessels, each containing sixty litres, were prepared. These were filled with the straw-infusion, to which peptone and grape-sugar had been added, neutralised with sodium carbonate (*mit kohlen-saurem Natron*), and sterilised by being boiled thrice for two hours in a current of steam. After the vessels had cooled down to 40° C., they were charged with a pure culture of bacillus, and submitted to a temperature of over 30° C. After two days, the bacilli were developed in the vessels in great abundance. At the same time, with the friendly aid of M. Pampoukis and his assistant, M. Metaxas, 412 tubes were filled with pure culture on obliquely-stiffened "Agar." With each Agar-tube we were able to impregnate at least a litre of water in which the pieces of bread designed to infect the voles were to be dipped. We had thus sufficient material to infect a large district in case the bacillus-laden infusion should have been spoiled in transport.

On April 16th we set sail in company with M. Pampoukis for Volos, arriving there early on the 18th, and took the train to Larissa, the capital of Thessaly, in the neighbourhood of which we were to commence our proceedings. On the road we encountered in the neighbourhood of Velestino great flocks of Buzzards, Kites, Sparrowhawks, and Storks, flying around the fields and fallow lands. It has been observed in other countries, too, that an increase of Field Voles is usually accompanied by a great increase of the various animals which prey upon them. The railway traverses a wide plain, bordered on the east by the Kissavos (the ancient Ossa), and on the north by the snow-covered Olympus. The plain is bounded on the west by a low chain of hills, and is the most important of the plains infested by the voles near Larissa. The whole of Thessaly is really one vast plain bordered by mountains, and divided by the range of hills just mentioned into the plain of Larissa and the plain of Trikala. It is traversed from west to east by the River Peneios, which descends from Pindos into the plain near Kalabaka, south of the wonderful rock-monasteries of Meteora, and leaves the plain north-east of Larissa, between Olympus and Kissavos, forming the beautiful vale of Tempe. The soil is extremely fertile, heavy, and in many places reddish loam, which is often inundated by the Peneios in winter over a large extent of country. These inundations are connected with the frequent occurrence of intermittent fever in the low-lying districts. The whole plain is treeless, except near Velestino, the first station on the line from Volos to Larissa, which may be due to a large number of springs which rise there. This vast fertile plain is for the most part the property of large landholders. Some of these gentlemen own as much as a hundred thousand acres of land. The population is very scanty. The villages are mostly small and unimportant. The houses are built close together in such a manner as to encompass the much larger mansion of the owner like a wall. Every peasant has a certain portion of the area allotted to him for cultivation, and receives a share of the harvest in return for his labour. The comparatively small number of inhabitants is of course insufficient to cultivate these extensive flats. Very large districts, perhaps more than two-thirds of the country, lie fallow. The fallow lands are used to pasture large flocks of sheep, goats, and herds of oxen.

About every three years the same tracts of land come into cultivation. There is no artificial manuring of the soil. In these extensive fallow fields the voles can multiply undisturbed. Last year the harvest was a good one, for the first time since Thessaly again became Greek territory. The Field Voles, which have always been plentiful in Thessaly (the ancient Greeks had their Apollo Smintheus, or Myoktonos, the Mouse-destroying God), multiplied considerably on account of the good harvest. The following winter (1891-92) was very mild, and did them no harm, and therefore at the end of February, when a warm spring set in, they appeared in larger numbers than for twenty-five years previously. The Station-master at Velestino, M. Amira, was the first to call public attention to the appearance of immense numbers of voles at the end of February. The notion of their sudden invasion of the Thessalian plain is out of the question.

As soon as public attention was directed to their appearance, it was confirmed by reports received from very different and widely-separated localities, in the Plain of Larissa. These simultaneous reports led to the notion that there must have been an invasion from without, but this was certainly not the case. At the beginning of March the voles were only beginning to troop from the slopes of the hills and the fallow-lands to the cultivated fields. It was frequently observed that they followed regular paths during their inroads. Thus they advanced along the railway embankment; their progress seemed to be rather slow. Perhaps they do not advance further till the inhabitants of one of their strongholds or so-called castle (*Burg*) have become too numerous. The "runs" which they excavate are at a depth of about twenty to forty centimetres below the surface of the ground. The extent of these "runs" varies, and we found them extending in length from thirty to forty metres and more. These "runs" are connected with the surface by vertical holes of about five centimetres in diameter. In many places four, five, and more holes led to the same "run." In such cases there is generally not far off an enlargement for the nest, lined with finely-gnawed vegetable material, where the young are produced and reared. In front of newly-opened holes, the earth, which has been thrown far out, forms smooth hillocks. There were many well-defined and well-trodden paths on the ground, by which the voles pass from one hole to another. They are never seen out of their holes by day, not even in places where the entire ground is riddled with holes like a sieve. They do not come out in search of food till evening; even then not many are to be seen, but the peculiar squeaking noise they make is heard everywhere. Next day all sorts of freshly-severed fragments of plants are found in the holes. Stalks of corn they manipulate by standing on their hind legs, and gnawing through the stalk; when this is bitten off they drag it into their holes to devour it there, and sometimes make it smaller. They are extremely prolific. Beginning in March, the female produces from six to twelve young ones every month. A reliable observer informed me that he had counted twenty-one fœtuses in the uterus of a pregnant female. The danger to the fields consequently increases every month. The number of voles noticed this spring was apparently as large as in 1866. At that time also they were first noticed in the fallow-fields; but, as the present mischief done to the fallow-fields was but slight, the voles attracted no particular attention, and no measures were taken for their destruction. But when the vertical rays of the sun dried up the fallow-fields at the end of May, 1891, as happens every year, the mice invaded the cultivated fields, in which alone they could find food, and caused such terrible ravages in a short time that last year scarcely any harvest was gathered. How suddenly, and with what amazing rapidity, the voles did their work of destruction is recorded in the reports of several official commissions. One evening a field was visited, which was to be mowed the following day; but when the labourers came to the place next morning they found nothing left to cut. The voles had destroyed the entire crop in a single night. A miller in the neighbourhood of Velestino reported that he went to his field early one morning, cut a measure of corn, loaded it on his ass, and brought it to his mill. When he returned with a second load to his mill, he found scarcely a vestige of the first load remaining. Thinking the corn had been stolen, he kept watch, intending to catch the supposed thief in case he returned. But suddenly, to his great astonishment, hosts of Field Voles appeared, which immediately set to work to carry off the second load.

Recollecting the experiences of 1866, the principal Thessalian landowners immediately formed a committee to take measures against the voles as soon as their appearance in large numbers was reported. The president and most active member was M. Anastassiades, the manager of the large estates of M. Stafanovic. It was this M. Stafanovic who telegraphed from his residence at Pera, Constantinople, to Prof. Pasteur in Paris, inquiring whether he happened to possess a microbe which could be used for the destruction of the Field Voles. Prof. Pasteur telegraphed back that he should apply to me, for I had discovered a microbe which would destroy them. This reply was forwarded to the Government at Athens, and I have no doubt that the recommendation of the distinguished French bacteriologist had some influence in deciding the Greek Government to invite me to come to Greece with an assistant.

The great danger which threatened the Thessalian harvest was at once appreciated to its full extent by the Greek Government. This year the harvest promised to be an uncommonly good one. The amount at stake was estimated at from 40,000,000 to 50,000,000 francs. The Government immediately appointed a number of specialists to deal with the voles. These were M. Kyriakos, Sub-director of the Agricultural School at Athens; M. Ambelikopulos, Professor at the Normal School at Larissa; and M. Muratoglos, Professor at the Normal School at Almiro.

These gentlemen, accompanied by a number of pupils, visited the localities which were most severely threatened in the neighbourhood of Velestino and Larissa, and began to deal with the voles in the middle of May. The measures taken by these gentlemen previous to our arrival consisted in flooding the infested arable land with water, in scattering poisonous food, in sinking large tin vessels in the ground, and in pouring bisulphide of carbon (*Schwefelkohlenstoff*) into the "runs." But the flooding of the "runs" could only be carried out in a few places, partly for want of water, and partly because the local conditions were unsuitable. However, what the Committee were able to do was attended with good results. They reported that the bisulphide of carbon had succeeded well. In using it, the first step taken was to close up all the openings to a colony. Next day all the newly-opened holes but one were closed. The nozzle of an injection-tube was inserted into this one open hole, and a measured quantity of bisulphide of carbon, of about 10 cm., was forced into the "run" by a special apparatus. It was asserted that all the voles inside were killed in a few seconds by the vapour diffusing itself through the "runs." The Committee informed us that they had found a great many dead mice on digging up a burrow that had been thus treated. But the use of bisulphide of carbon was also only possible in certain suitable localities, that is, only where the holes in the ground were visible; for the fallow-fields were covered almost everywhere with great thistles almost as tall as a man, and the voles prefer to make their holes under cover of these. Again, if all the holes of a colony are not closed before the injection of the bisulphide of carbon, the vapour, and probably the animals too, will escape through the openings which have been left. At the time of our arrival the first supply of bisulphide of carbon furnished by the Government had been exhausted, and it was very difficult to obtain the large supplies which were ordered from France *viâ* Marseilles, for no vessel would carry on board a large quantity of this dangerously-inflammable substance. Moreover, the use of bisulphide of carbon became unadvisable about the end of April, because at this time of year the heavy soil had already become parched and cracked by the sun, and the vapour escaped through the fissures, without doing any execution in the "runs." As the heat increased, too, there was much loss of material. Bisulphide of carbon boils at 46·5° C. In the open fields, and exposed to the sun, the vessels containing the chemicals were easily heated above the boiling-point. The inconvenience to the workmen, and the danger of fire, increased in proportion to the temperature. The scattering of poison frequently resulted in the poisoning of sheep, so that the country people were full of distrust of this method. The nett result of the measures already adopted was to be estimated at next to nothing in view of the swarms of voles existing, and the extent of territory infested.

My arrival was awaited with mingled feelings. Many, especially the owners of large estates, hoped that a thorough success might be attained through the bacillus which I had discovered. Others, and particularly the specialists commissioned by the Government, did not entertain much hope of the success of the bacteriological method, because, however satisfactory might be the results obtained in the laboratory, the experiment had not yet been tried in the open air. An unfavourable opinion had been formed of my undertaking owing to the failure of the bacteriological method in contending with the Australian rabbit-plague.

No time was lost in carrying out the new method. Mice abounded everywhere in the Plain of Larissa. By the advice of Dr. Pampoukis, the land selected for the initiatory experiments belonged to intelligent Greek owners of large estates, because we could rely upon them to carry out my plans strictly. The country people were mostly indifferent about the vole-plague. The Turkish inhabitants of the country regarded it as a visitation of God, which must be submitted to. In general they were disinclined to try any remedial measures. The notions of the Turks were well illustrated by their sending messengers to Mecca to fetch holy water, with which to sprinkle the fields, and thus, as they supposed, exorcise the mice. The peasants were mostly very indolent, and required some pressure to make them work. The Prefect of Larissa, M. Kleomenes, gave us the greatest assistance in every way, and put soldiers at our disposal, who were sent to the villages and compelled the peasants to take the needful measures. The requisition of a military escort for our personal safety, which seemed somewhat threatened by the reports published in the German papers of the appearance of mounted bands of brigands in Thessaly, proved quite unnecessary. The news in the German papers was either incorrect or greatly exaggerated, as was also the case with similar news in many

Greek papers. It was most likely designed to throw difficulties in the way of the Government before the impending election. The only item of truth in the whole affair was greatly worked up by the Opposition journals, and what gave apparent countenance to the reports was that shortly before our arrival a number of prisoners had escaped from the prison at Larissa. In order to sustain their lives these people had committed some depredations in the neighbourhood of Larissa, and had consequently caused a certain amount of uneasiness among the inhabitants. At last they were forced to take to flight together. Some surrendered, others were soon recaptured by the soldiers sent in pursuit of them; others again fled across the Macedonian frontier to the mountains. During our excursions to the different districts infested by the voles, I never felt any insecurity; we had always an under officer in the carriage with us, and we were always accompanied by two mounted and armed retainers of the owner of the estate we were visiting. But these people attended not so much to protect us, as to be ready to carry news quickly to places at a distance.

My plan for the practical employment of the bacillus was to dip bits of dry bread (white bread, if possible), about as large as a finger-joint, into the fluid charged with bacilli, and to put a bit of this bread into each mouse-hole. If the animals ate the bread they would certainly die, as in the case of the laboratory experiments. The disease would be communicated to those which had not eaten the infected bread partly by the bacilli in the excreta of those affected but still living, and partly by their devouring the bodies of those which died of "mouse-typhus." The mode of carrying out these measures was very simple. Making Larissa our head-quarters, we made daily excursions to places in the neighbourhood, taking with us the large tin vessels containing the fluid, and about 100 phials of pure culture on "Agar-Agar." As soon as we had about reached the middle of the district we proposed to deal with, a quantity of the fluid was poured into a pot, which the owner willingly gave us, and the contents of some "Agar-tubes" were added to it, that the fluid might be as strongly charged with bacilli as possible. The soldiers then summoned the peasants from the neighbouring villages, telling them to bring slices of bread with them, to this central spot, each bringing a sufficient quantity of bread with him for the piece of land on which he worked in a wicker basket. One after another went to the pot, and poured the contents of his basket into the fluid. The pieces of bread were then dipped down, and after they had been sufficiently soaked, were taken out of the pot with the hands, and put back into the basket. In order to relieve the peasants of the doubts which they expressed whether the prepared bread might not be poisonous to their sheep, the animals belonging to the establishment,—fowls, pigeons, dogs, pigs, horses, donkeys, sheep, and goats,—were all fed before their eyes with prepared pieces of bread; indeed, some of the staff who divided the bread among the peasants ate pieces themselves in their presence, to show that it was harmless also to man. It is true I had made no previous experiments upon man, with the bacillus, but only expressed my opinion that I considered it improbable that any harm could result from the bacillus. But this declaration was quite sufficient to induce my companions, who were most zealous for the success of the undertaking, to try the experiment for themselves of eating some of the bread without more ado, in order to tranquillise the peasants. In short, all of us who had to dose the bread, as well as the peasants who had to divide it, served as objects of experiment; for disinfecting our hands, and the baskets used to carry the bread was, of course, out of the question.

All these experiments on men and animals proved (as I had expected from the result of my former trials) that, so far as they are concerned, the bacillus is wholly innocuous; it is operative only on the alimentary system of the House Mouse and Field Vole. After the peasants had been taught and shown what was to be done, they went as they were ordered to their fields, accompanied by soldiers, and carried out their instructions faithfully. We ourselves selected suitable posts for observation in different places, and applied the method there, in both the cultivated and fallow-fields. In this manner we succeeded, in a few days, in disseminating the prepared bread over the whole plain, north, east, and west of Larissa. At different places dozens of voles were innoculated with the pure culture by subcutaneous injection, and were liberated in the fields that they might spread the disease in the way already explained.

I cannot sufficiently express my grateful recognition of the hospitable reception which we received everywhere from the owners of the estates, and their stewards, and of the energy with which they urged the people to carry out the method practically. I am especially grateful to the owner of Bakrena, M. Kalamopolus, and his representative, M. Elias; the owners of the estates of Nechali, Demetriades, and Skaliora; and, above all, to the director of the Stefanovic estates (Chassambali, Metesseli, Amarlar, Chadsimustafa), M. Anastassiades, who unweariedly exerted himself to ensure the measures which I proposed being conscientiously carried out.

In a few days the supply of cultivated fluid and the pure culture on "Agar" was exhausted. But after the method became known, those of the inhabitants who did not live too far from Larissa flocked to the town to obtain infected bread to take to their fields. This obliged us at once to recommence our preparation of the cultivated fluid. The Government Commissioners shared in the work. M. Ambelikopulos, in particular, took care to acquaint himself with all the details, so that he might be able to extend the use of the method through all Thessaly after our departure.

It was necessary to make a reliable experiment on a large scale in Thessaly with the fluid prepared at the house of M. Anastassiades. I entrusted this work to my assistant, Dr. Abel, there being doubtless a great abundance of field mice in the neighbourhood of Velestino, as we afterwards found to be the case when we visited the fields; and consequently this district seemed particularly suitable. I therefore sent Dr. Abel there with a supply of the freshly prepared material, and directed him to select a suitable field, to dig a ditch round it, and to sprinkle it with the prepared bread. Dr. Abel succeeded in discovering, through the friendly aid of M. Maire, of Velestino, and his assistant, M. Jourdan, a wheat-field, about four hectars in extent, which was riddled with mouse-holes like a sieve. In order to isolate this field from its surroundings as far as possible, he had a furrow ploughed all round it, and immediately deepened this into a ditch. At the same time all the holes were charged with bread. By this method the following results were obtained: —After a few days news was received from all quarters that the bread which had been put into the holes had disappeared, and therefore it was in the highest degree probable that the voles had eaten it. If this were the case the result would be very satisfactory, according to the experiments made on a small scale. From the first I awaited the result with great anxiety. I had not thought it very likely that the voles would eat the bread when they were surrounded with the tenderest grasses. On this account I expressed the opinion in the article already referred to ('Centralblatt für Bakteriologie und Parasitenkunde,' Band xi. p. 129) that Spring and Autumn were the most favourable seasons for attacking the voles by my method; that is, at seasons when their natural food was not over abundant. In Thessaly this period was long past, and the finest and tenderest grass was growing everywhere. The corn had already attained a height of half a metre and upwards. I was therefore all the more agreeably surprised when the news reached us that the bread had everywhere disappeared from the holes, even in the midst of the cornfields. We could not expect final results until the expiration of at least four weeks, but after about nine days some of the consequences became apparent. In company with Dr. Pampoukis, who had been deputed by the Government to assist us, and who had made things smooth for us everywhere, and with the landed proprietors who were most interested, we made a tour of inspection at the expiration of the time mentioned to the places where we had ourselves applied the method, as well as to some where the proprietors assured us it had been undoubtedly carried out by the peasants. In Bakrena, where we had commenced the trial nine days previously, the devastations in the fields had ceased for two or three days. We were able to ascertain with certainty that freshly-eaten corn was no longer found in the holes; what was actually found was at least two days old. Besides, we saw no newly-opened mouse-holes. At several places all the holes had, at my request, been trodden down the evening previous to our visit. Not one of them had been reopened, as was otherwise invariably the case under similar circumstances. Several dead voles had been found by the peasants, but unfortunately they had not been preserved. It was just the same at Nechali and Amarlar. A number of the burrows were dug up; many were quite empty, and in others dead young were found, partly eaten. At other places dead voles were found just outside the burrows, or sticking in the holes; we also found half-dead ones moving about outside the holes in broad noonday, which they had never been seen to do at other times. This discovery of dead and dying voles outside the holes in broad daylight explained the reason why we seldom found dead ones when the burrows were opened. It seems that when the animals find themselves seriously ill they feel the need of fresh air; they abandon their holes and "runs," and are immediately pounced upon and devoured by the numerous mouse-eating birds in the neighbourhood. A number of dead and half-dead voles were taken back to Larissa, and were there examined; they all exhibited the pathological and anatomical changes of mouse-typhus, and all their organs, especially the liver and spleen, contained abundance of characteristic bacilli. Thus we conclusively proved the infection of the voles by means of the prepared bread. The method had satisfactorily borne the test of practical application. It was no longer necessary for me to remain in Thessaly, as I could entrust the further carrying out of the method to Dr. Pampoukis at Athens, and M. Ambelikopulos at Larissa. Dr. Pampoukis announced the satisfactory result of the experiment in a despatch forwarded to Athens. The Mayor of Larissa, M. Asteriades, gave a dinner in our honour, and expressed his pleasure at the success of our undertaking; and the Prefect, M. Kleomenes, who was present, also expressed his appreciation of the value of the new method. The President of the Committee, M. Anastassiades, was so convinced of the result that he telegraphed to countermand the further shipment of large quantities of bisulphide of carbon, which were lying at Marseilles to be forwarded to Thessaly. The Government Commissioners also recognised the success of the method.

After this we returned to Athens. I personally reported to his Excellency the Prime Minister, M. Konstantopulos, respecting the fortunate results of the experiment. I laid stress upon the pressing necessity for carrying out the method without delay throughout the whole of Thessaly. I expressed my confident opinion that there would be a very good harvest this year from the Thessalian corn-lands, if they were saved from destruction by the voles through a speedy and widespread application of my method, which could easily be carried out; and finally expressed my desire that the Government would give Dr. Pampoukis, at Athens, and M. Ambellikopulos, at Larissa, full powers and means to carry out the method in the way which I had shown them. His Excellency the Prime Minister then expressed to me the thanks of the Government, in the presence of M. Gennadius, the Director of the Agricultural Department of the Ministry, for having accepted the invitation, and for having successfully carried out my method in Thessaly for the benefit of Greece. His Excellency, M. Trikoupis, who had paid special attention to the Thessalian vole-plague, and had learnt with great interest the particulars of my method, its easy application, cheapness, and effectiveness, also expressed his conviction, during a visit which we paid him, that we had rendered Thessaly and Greece a great service by practically conducting this novel undertaking. During the two following days which we were able to spend in Athens before our return to Germany, several telegrams were received from Thessaly, setting forth beyond doubt the successful results of the experiment from day to day. The Greek journals of all parties were unanimous in expressing their approval of my method, and their gratitude. Moreover, M. Gennadius, the Director of the Agricultural Department, and all the scientists connected with the Pathological Institute, who had energetically aided in the preliminary arrangements, expressed their pleasure at the complete success of the undertaking during a banquet which in the most friendly manner they gave in our honour.

We made our return journey *viâ* Constantinople. Shortly after our arrival, I received a telegram from MM. Anastassiades and Kyriakos, giving information of the latest results of the experiment, as shown by the discovery of great numbers of dead and dying mice, and expressing their gratitude and good wishes.

On my return to Greifswald, I received no further news for a time. As I said before, the complete results could not be expected to manifest themselves for some weeks after the commencement of the practical application of the method. On May 26th I received, to my great satisfaction, the following despatch from the President of the Vole Committee at Larissa, "Résultats excellents partout, pays réconnaissant à vous.—Anastassiades."

On May 28th, I received a letter, dated on the 22nd, from M. Ambelikopulos at Volos, in which he expressed himself as follows:—"Votre méthode marche très bien, elle nous a donné des résultats splendides; à Velestino où nous avons fait un essai, on a trouvé beaucoup mais beaucoup de campagnols morts et assez de mangés dans la nuque."

Thus the hopes which I entertained when I discovered the bacillus, that it might prove of great importance in counteracting the damage, amounting to many millions, caused by voles in several countries of Europe, have been fully and speedily confirmed. We now possess, in the *Bacillus typhi murium*, a microorganism which will infallibly kill these destructive rodents. The bacillus can be used in practice with the greatest ease, as it injures no other animal. It consequently fulfils the most comprehensive requirements necessary in a method for destroying voles. For the first time an injurious animal in Thessaly has been successfully and scientifically got rid of. Bacteriological science has again proved its vast practical importance, and has fully justified its claim to be studied and cultivated to the utmost extent.

NOTES AND QUERIES.

MAMMALIA.

The Polecat in Pembrokeshire. — With reference to the note which appeared under this heading (p. 264), and to the replies thereto (p. 310), Mr. E. Cambridge Phillips writes that it was the Marten, and not the Polecat, which he intended to characterise as extinct in Pembrokeshire. His letter dated "Brecon, July 25th" reached us too late for insertion in the last number.—ED.

Young Squirrels.—I have just been reading Mr. Blagg's interesting remarks about Squirrels in 'The Zoologist' for March, 1891 (p. 101), and should like to mention that in 1887 I found young Squirrels in the woods near Oxhey, not far from Harrow-on-the-Hill, on May 28th. One lot of three, which were in a "drey," had their eyes open; but I found a much younger lot in a hole in a tree on the same day. In this county (Wexford), in 1891, I was shown, on August 14th, two quite small Squirrels which had recently fallen out of their "drey." They were still living when I saw them, but were so young that their eyes were not yet opened. These instances seem to support Bell's testimony as to the date of birth of young Squirrels rather than that of Mr. Blagg.—G. E. H. BARRETT-HAMILTON (Kilmanock, New Ross, Co. Wexford).

[In our editorial note, however, to Mr. Blagg's communication, the reader will observe that we have given four dates in March and April, which support his contention that the Squirrel has young long before June, the date assigned by Bell.—ED.]

Barbastelle in Gloucestershire.—A female specimen of this bat was sent me by Mr. C. Watkins, of Painswick, it having flown into the room of a house in Stroud during the first week in August.—H. CHARBONNIER (7, Triangle, Clifton, Bristol).

[The only Bats mentioned in Mr. Witchell's lately published 'Fauna of Gloucestershire,' of which we hope shortly to give a notice, are the Noctule, Pipistrelle, Natterer's Bat, Whiskered, Long-eared, and the two Horseshoe Bats. It is curious that the additional species now recorded should have turned up in the town in which the author of the 'Fauna' resides.—ED.]

Hairy-armed Bat in Yorkshire.—During the months of May and June, 1890, I obtained several specimens of the Hairy-armed Bat, *Vesperugo leisleri*, which were shot on the wing at Mexborough. One of the specimens is now in the British Museum.—H. CHARBONNIER (7, Triangle, Clifton, Bristol).

[It appears from Messrs. Clarke and Roebuck's 'Handbook of the Vertebrate Fauna of Yorkshire,' that only one occurrence of this bat in that county was known to them at the date of publication, 1881. It would be of interest if our correspondent would point out in what respects the specimens procured by him differ from the young of the Noctule with which *V. leisleri* has before now been confounded.—ED.]

Black Variety of the Water Vole in Northumberland.—It appears from Messrs. Aplin and Macpherson's paper on this variety of the Water Vole (p. 247) that it has not yet been reported from Northumberland. I spent a fortnight last May at Harbottle, in Upper Coquetdale. Whilst walking by the river one evening with a keeper, on the look out for an Otter, our attention was attracted by a Water Rat. Without any remark on my part, my companion inquired, "Do you see Black Water Rats in Nottinghamshire?" On my informing him that occasionally I had seen them, he told me that he frequently saw them when fly-fishing in the Coquet. After that I kept a look out, and was rewarded by seeing a very black specimen at a place called Shilmoor, several miles higher up the river, a day or two later. This specimen dived into a deep pool of the peat-coloured water, and I was much struck by its instantaneous disappearance from sight, though the water was clear, the dark colour of the fur making the animal invisible when only a few inches under water.—F. B. WHITLOCK (Beeston, Notts).

Bank Vole breeding in Confinement.—At the end of last March I received about a dozen specimens of the Bank Vole, *Arvicola glareolus*, from Haresfoot Farm, near Berkhampstead. They were found by the labourers in a large nest made of dry grass in a heap of mangels. There were a good many of them, and those sent me were caught alive by the men in their hands. I had a cage made for them, after the fashion of, but larger than, the common dormouse-cages, divided into three parts—one for sleeping, another for food, with, at the end, a revolving wheel or treadmill. Into this I put five of the voles. They are fed with corn, apples, carrots, potato, bread, biscuit, and (by advice read in 'The Zoologist') gooseberries. They are well supplied with water. On the 23rd July I found two blind, hairless young ones, evidently just born, lying outside the cage, underneath the wheel. I put one into the sleeping compartment, where I caught sight of another. I gave strict orders that this part of the cage was not to be disturbed. When, however, the voles were shut into it, to permit of cleaning the other parts, the little girl who attends to them several times heard sounds of fighting, and on the morning of the 26th a vole ran out bleeding at the head. He was followed by the mother, with a young one in her mouth. Our idea is that the wounded vole had attacked the young ones, and had been bitten by the mother. He was found dead the next day. On the 2nd August (when the young ones were eleven days old) one was seen running about. After a fortnight (the 6th August) I examined the sleeping-place, and found three little creatures fully covered with fur, active enough, and able to feed themselves. The mother is very jealous of her young ones being seen, and it is amusing to notice how she seizes a youngster, and hustles it off to the sleeping apartment if she thinks it is being looked at. Once or twice when a little one has ventured into the wheel, she has not only trundled it back, but has (apparently) administered correction by shaking and thumping it on the floor as she carries it to the inner compartment. All the little creatures appear in excellent health, which I attribute mainly to the wheel. This enables them to get as much exercise as they please, and they never seem to tire of it.—T. VAUGHAN ROBERTS (Verulam House, Watford).

BIRDS.

Summer Birds kept through the Winter.—It may be of interest to mention that a Norfolk naturalist, Mr. Lowne, of Great Yarmouth, has successfully kept a Swallow, a Wheatear, a Greater Whitethroat, a Blackcap, and a Pied Wagtail through the winter. On the 22nd July they were in as good health as if they had just come over the channel, and the Swallow is reported to be "singing all day." My brother and I have had Hedge-sparrows, which are not easy birds to keep, for some months, and I have a Brambling which has assumed the summer plumage and a black chin.—J. H. GURNEY (Northrepps, Norwich).

[An article on the treatment of Swallows and Swifts in captivity was published in 'The Zoologist,' 1887, p. 372. Blackcaps and Whitethroats have been successfully kept through the winter by the well-known zoological artist, Mr. Joseph Wolf, and visitors to the Zoological Gardens will doubtless remember the Pied Wagtails which lived so long in the Aviary at the end of the Fish House.—Ed.]

Young of Red-necked Grebe on the Kingsbridge Estuary in July.—An immature bird of this species, *Podicipes rubricollis*, was observed during the month of July haunting the vicinity of the new bridge, in company with a flock of tame ducks; much to my regret, it was shot on August 1st, and brought to me. The specimen shows the peculiar black and white stripes about the face and cervical region, whilst the lower neck and upper part of the breast are of a warm chestnut colour. I am much inclined to believe this bird was bred in the neighbouring Slapton Ley, though it has been hitherto said never to have bred in Great Britain.—Edmund A. S. Elliott (Kingsbridge, Devon).

Birds of Derbyshire.—I venture to appeal to the readers of 'The Zoologist' for notes respecting Derbyshire birds in general. A reference to the current journals on Natural History will show the very scanty material contributed respecting the county at the present day. Information, especially concerning local specimens in museums and collections, is greatly desired. Lists of the commonest species would be welcome, as well as the reference to old works on Derbyshire containing any information referring to the avifauna of the county. Local lists, especially relating to water-fowl, from the country north of Chesterfield, and on the Cheshire border in the north and north-west, would be especially welcome, and would be duly acknowledged.—F. B. Whitlock (Beeston, Notts).

[The following works should be consulted:—*Leigh*, Nat. Hist. Lancashire, Cheshire, and the Peak in Derbyshire, folio, 1700. *Glover*, Sketch of the Zoology of Derbyshire (Birds), in Hist. Co. Derby, 1829, vol. i. pp. 139—166. *Briggs*, Birds of Melbourne, Derbyshire, 'Zoologist,' 1849 and 1850 (several articles). *Pullen*, Birds of Derby and Neighbourhood, in 'The Young Naturalist,' vol. v. pp. 30—34, published at Hartlepool, 1884. *Whitlock*, Birds of Derbyshire Peak, 'Naturalist,' 1886, pp. 130—132. Perhaps some of our readers may be able to supply other references that may be useful.—Ed.]

Cuckoo in Grey Wagtail's Nest.—In Messrs. D'Urban and Mathew's recently published 'Birds of Devon,' will be found an account (p. 40) of a pair of Grey Wagtails nesting in the wall of the town reservoir at Kingsbridge for several years until the spring of 1890, when they were ousted by a pair of Pied Wagtails. In the spring of 1891 a pair of Grey Wagtails frequented the precincts of the reservoir for some days, but as the Pied Wagtails had already possession of their favourite hole, the former left. This year a pair of Grey Wagtails again appeared rather late in the season, and commenced to build in a hole in the opposite wall of the reservoir to the original nesting-place, and had the bad luck to attract the attention of a

Cuckoo, which deposited an egg in the nest. The young Cuckoo could subsequently be seen in the nest very plainly; but the foster-parents were shy of feeding it whilst being watched. Eventually the young Cuckoo fell out of the nest into the water, and was drowned.—EDMUND A. S. ELLIOTT (Kingsbridge, Devon).

Blue-headed Wagtail and Little Owl in Oxfordshire. — As the publication of my report on Oxfordshire Ornithology for 1891 will be delayed, I should like to place upon record the occurrence of two birds which are new to the county list. Mr. W. Warde Fowler wrote me word that on the 29th April, 1891, he saw among a company of *Motacilla raii* in Port Meadow, Oxford, one which he "had little doubt was *M. flava;* dark head, and back darker than *M. raii,* and altogether different from the rest, including females." On the 2nd September in the same year, I saw close to the same spot a Wagtail of this species. I got within three yards of it, and watched it for five minutes as it caught flies in the shelter from the wind afforded by some long grass and rank weeds. It was over the moult, but the head had a decidedly grey tinge as compared with the back, and was also darker than the latter; white eye-streak conspicuous. It is highly probable that the Blue-headed Wagtail bred there in the summer. A Little Owl (*Athene noctua*), which I have examined, was caught in a rabbit-trap in a bank near Thame, and sent for preservation on the 11th November, 1891.—O. V. APLIN (Bloxham, Banbury, Oxon).

The Marsh Warbler in Notts.—I feel convinced that, three years ago, on 2nd or 3rd July, I heard a Marsh Warbler singing in an osier-bed near Nottingham. I was then living at Attenborough, and had started to walk down the Midland Railway from Beeston Station, where I had arrived by the midnight train. Attenborough is about a mile and a half from Beeston, and midway between the two places a large osier-bed extends from the Trent to the railway, covering about nine acres. The night was close; during the day a heavy thunderstorm had occurred, and everywhere was reeking with moisture. On nearing the osier-bed I noticed that both the Sedge and Reed Warblers were singing, but the song of another bird was so different to anything I had heard before, that I stopped to listen as soon as it commenced. It is always difficult to write down the song of any bird on paper, but the song I was listening to appeared to be most like that of the Nightingale, without the long-drawn plaintive notes of the latter bird, and with more of a ripple about it, sometimes not unlike that of the Sky Lark, but with occasional harsh notes thrown in. It was far more musical than that of the Reed Warbler, and not so hurriedly uttered as that of the Sedge Warbler, as though the bird was conscious or its sweeter strains. It must be remembered that both these species were singing close at hand; I had therefore excellent opportunites for comparison. The bird appeared to be singing in a part of the osier-bed about 150 yards from where I stood. Unfortunately a heavy luggage-train soon came by and silenced my bird, which did not resume its song whilst I was within earshot. The Sedge and Reed Warblers, however, scorned to be interrupted. I was unable to revisit the spot for more than ten days, and so did not hear the warble again. In the two following years the osiers were cut in the spring, so that there has been no cover for the bird, even if it has returned to its previous haunt. In his recently published notes (p. 303), Mr. Fowler speaks of the Reed Warbler as "lethargic." I can hardly agree with him there. I consider it very animated, and even pugnacious at pairing time. When singing, too, the Reed Warbler, like the Marsh Warbler, shows the bright yellow interior of the bill "as he stretches it wide, with head erect." He is a mimic also, and on hearing a Reed Warbler singing so much like a Sedge Warbler, I shot it, thinking I had found the true Marsh Warbler at last. I had been reading Bree's article a day or two before. I have noted the "*utic-utic*" notes of the Whinchat in the song of both the Sedge and Reed Warblers; indeed, the former bird frequently uses them as a sort of prelude. Writing on the Sedge Warbler, Mr. Fowler remarks that on one occasion he saw one "dance up into the air like a Whitethroat, and descend something after the manner of a Tree Pipit." I have frequently witnessed this, especially just after the birds have arrived; sometimes they sway themselves about in the air rather like a Greenfinch does. — F. B. WHITLOCK (Beeston, Notts).

Grasshopper Warbler in S.W. Scotland.—This is a shy, retiring little bird, which, though not really rare in S.W. Scotland, is very seldom heard and still more seldom seen, and the finding of its nest by any except those who possess the key to its habits a rare accident. This season some of the birdnesting boys seem to have stumbled on the bird somehow, and no less than three different juveniles brought me eggs of this bird for identification. These had all been taken within a short distance of Dumfries. — ROBERT SERVICE (Maxwelltown, Dumfries).

Late Nesting of the Lapwing.—The breeding time of these birds last spring was brought to a rather abrupt conclusion, owing to the dryness and coldness that prevailed then. In June they seemed to have actually commenced to nest again, and during the last week of July it was no uncommon thing to find young birds newly emerged from the shell running about in the soft downy plumage. In ordinary seasons, of course, Lapwings in the youngest stages are regularly found so late in the season as this in places where the eggs have been taken early in the spring. But this year, in the cases I am referring to, the birds seem to have been undisturbed by anything, except the unfavourable weather. In this connection I may be allowed to mention an interesting fact that can be vouched for. No less than 120 dozen of Lapwings' eggs were gathered in a single day on a certain Stewartry estate by the gamekeepers and their assistants.—ROBERT SERVICE (Maxwelltown, Dumfries).

Ruddy Sheldrakes in Ireland.—The end of June and the beginning of July last were marked by the occurrence of several Ruddy Sheldrakes in flocks in Ireland, and one in Scotland. The 'Irish Sportsman' of July 23rd contains information as to a flock of seven on the Co. Dublin coast, two of which had reached Mr. Williams during the first week in July, as he then informed me. In 'The Zoologist' for August (p. 311) Mr. Steele Elliott mentions a Ruddy Sheldrake, which was shot towards the end of June out of a flock of twenty in Co. Donegal. On the 25th July, Mr. Levinge, of Knockdrin Castle, Co. Westmeath, wrote to tell me that there were two strange birds on a neighbouring lake, and, on consulting Yarrell's 'British Birds,' he subsequently told me that they were "undoubtedly Ruddy Sheldrakes." We learn, from 'The Field' of Aug. 6th, that six or eight of this species took up their quarters in July in a small bay west of the village of Findhorn, on the Moray Firth, and that one of them was shot. Referring to 'The Zoologist,' 1887, p. 25, we find that in June and July, 1886, three separate parties of Ruddy Sheldrakes occurred at Kinsale, near Banteer, in the north of Co. Cork, and on the Shannon. Earlier occurrences of this species in Ireland took place in Co. Wicklow, July, 1847; in Co. Kerry, August 17th, 1869; and in Co. Waterford, March, 1892. Such repeated appearances of the Ruddy Sheldrake in summer, simultaneously in different places in 1886 and 1892, and in flocks, seem to preclude the idea of their being all escaped birds, and to indicate that this species occasionally migrates at that season to the British Isles. As its breeding range lies so far south as the basins of the Mediterranean and Euxine, and Central Asia, these summer visits need not astonish us so much as would be the case with other Anseres that go much further north to breed. With reference to the flock of supposed Wild Geese in Westmeath, mentioned by Mrs. Battersby (p. 310), Col. Malone, who saw them, writes to me:—"The keeper and I were on the lake (Lough Iron) about 11.30, on the 4th July, when I saw a large flock of birds coming towards the lake from the east. They came on to within 150 or 200 yards of us, when they wheeled and flew off in a northerly direction; they were flying rather low, about seventy yards, I should say, from the ground. I thought they looked to have slightly shorter necks than the geese one usually sees, and were a little darker in plumage. They made a cry that reminded me of the large horse gull (Lesser Black-back). There were either forty-seven or forty-eight of them. They were the same size as the geese one sees in winter." Mr. H. L. Jameson informs me that on the morning of the 31st July six or seven supposed Wild Geese were seen flying south-west by John Hanlon, farmer, of Drumbanagher, Co. Armagh.

Though Colonel Malone's description does not altogether agree as to colour and size with that of the Ruddy Sheldrake, yet, as the size and hue of birds on the wing may be mistaken, and as other flocks made their appearance in Ireland about the same time (at a season when Wild Geese are in the arctic regions), it is open to conjecture that the two last-mentioned flocks may have been Ruddy Sheldrakes. It will be interesting to note if the species has occurred this summer elsewhere in the British Islands.—R. J. Ussher (Cappagh, Co. Waterford).

[On the 28th March last a Ruddy Sheldrake made its appearance on a piece of water at Burley Manor, Ringwood, Hants, and was described in a letter to the 'Times,' dated "Burley Manor, April 12th," by Mr. W. C. Esdaile, who did all he could to protect it while it remained in his neighbourhood. In 'The Field' of August 6th, Mr. F. Menteith Ogilvie announced the recent occurrence of another bird of this species near Aldeburgh, Suffolk; and the Rev. H. A. Macpherson, in 'The Field' of August 13th, "reported that a third had been shot in Cumberland on July 20th."—Ed.]

A Tame Golden Eagle.—I promised to send you some account of the Eagle which our former under-keeper took from the nest near here. He is now the landlord of the hotel at Luib, and has still the bird in his stable. It is a Golden Eagle, I think a hen bird, and nearly, if not quite, full grown. It is fairly tame, and will sit on his hand; but he does not carry it often so, partly because he is a busy man, and partly because he is afraid of its losing its balance, and regaining it in a manner extremely painful. It has not been pinioned, nor had any of its feathers touched, and can fly very well. It escaped the other day, and flew for about half a mile, but settled on the ground, and allowed him to come up and catch it again. I think he wants to get rid of it, as his wife is afraid it will eat or injure her first-born, who has just reached that age when he can run about by himself. The owner has had one or two people enquiring about the bird, and has been offered a life-membership of the Zoological Society, if he will present it to the Gardens; but he does not think that good enough, as he can never derive any of the advantages except writing F.Z.S. after his name. He told me the story of its capture; it was the only one in the nest, and he was lowered by a rope. He found it surrounded by the remains of about thirty grouse, seven lambs, hares and rabbits in abundance, and rats, mice, and moles.—Francis Head (Luib Hotel, Perthshire).

Wild Hybrid Birds.—M. André Suchetet continues his observations under the title "Les oiseaux hybrides rencontrés à l'état sauvage." The third part of his essay (270 pages), dealing with the Passeres, has just appeared in the 'Mémoires de la Société Zoologique de France,' and further parts will complete the series. These published researches of M. Suchetet are of great interest to ornithologists, embodying as they do a great number of facts collected from various sources. We may especially direct attention to the pages relating to hybrids between *Turdus merula* and *Turdus musicus* (pp. 365—373), since this subject has on several occasions been dealt with in communications to this Journal.

REPTILES.

Results of Viper-bite. — As cases of poisoning from the bite of venomous reptiles are happily rare in this country, it may prove interesting to some of your readers if I relate my experience on this matter. About a month ago I caught two snakes at Bickleigh, near Plymouth, and whilst examining one it "bit" or rather struck me on the right thumb. I immediately sucked the puncture (it could not be called a wound), which bled a little, and tried to make light of the matter. A livid patch soon formed round the point, and the hand and arm commenced to swell. In a quarter of an hour I was unable to hold anything, and almost in a fainting condition. The first symptom (apart from the swelling) was a peculiar taste and a sensation of swelling in the teeth, then the tongue commenced to swell and became so large that I could hardly move it, my eyes seemed ready to start from their sockets. In half an hour a terrible vomiting commenced, preceded by excruciating pains in the stomach and heart, and continued with the pains altogether for nine hours, every drop of liquid being ejected almost as soon as swallowed. There was also violent purging and complete suppression of urine. There was practically no pain in the arm. Altogether the painful symptoms lasted for about nine hours. I did not lose consciousness at any time. The arm continued to swell for two days, and then it was nearly as large as my leg. After this the swelling subsided, but the arm did not return to its normal size until twelve days after the accident. After the swelling had gone I suffered very much from rheumatical pains, and, in fact, do so now, and the digestion was also very much impaired. The Viper is a male, a little more than two feet long, and about one inch in diameter at the largest part. Colour, a dull yellowish brown on the upper side, with a zigzag black line running down the whole length. On the under side it is nearly black except at head, where it is pale yellow. I have kept the reptile now for nearly five weeks, and, although well supplied with small frogs, &c., it has not eaten anything, and seems as lively as ever.—W. A. RUDGE (Plymouth), in *Nature*.

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